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Facility Data For The Hanford Integrated Disposal Facility Performance Assessment

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Abstract: Facility specific data relevant to the 2005 Integrated Disposal Facility performance assessment has been documented. A performance assessment conceptual model is derived from the facility data. Sensitivity cases relative to facility design are described.

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FACILITY DATA
FOR THE
HANFORD INTEGRATED DISPOSAL FACILITY
PERFORMANCE ASSESSMENT

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May 2004

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EXECUTIVE SUMMARY

The *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement* (DOE 2004) has investigated the options for disposing of anticipated quantities of low-level waste, mixed low-level waste, immobilized low-activity waste, and Waste Treatment Plant melters at the Hanford site. The Department of Energy (DOE) preferred alternative is to dispose of newly generated quantities of these waste forms in a new modular facility. This disposal option would include Hanford-generated wastes and could also include low-level and mixed low-level waste from currently approved off-site generators as well as from other DOE off-site generators, consistent with the *Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997).

The proposed Integrated Disposal Facility will be located on the Immobilized Low-Activity Waste site southwest from the PUREX facility on the Hanford Site. This site was analyzed in the *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* (Mann et al. 2001). The facility's trench design (Dehner 2004a) is a lined landfill approximately 410 m wide by up to 13.2 m deep. The length of the trench will be expanded to accommodate waste receipts during its operational life. The design includes sloped (3:1) side walls for the trench. The landfill will be divided lengthwise (north-south orientation) into two distinct cells, one for the disposal of low-level radioactive waste and the other for the disposal of mixed waste. Current operational plan would place the mixed low-level and immobilized low-activity wastes and spent melters into the western-most cell (Cell 1). The low-level waste would be loaded into the eastern-most cell (Cell 2). Waste forms currently planned for disposal in the facility include Waste Treatment Plant spent melters and immobilized low-activity waste glass, supplemental immobilized low-activity waste (both from Waste Treatment Plant and non-Waste Treatment Plant waste streams), and solid (low-level and mixed low-level) waste packages. The current closure plan is to cover the landfill with a modified *Resource Conservation and Recovery Act* Subtitle C barrier.

A conceptual model for computer studies in the next performance assessment (to be published in 2005) has been developed for the half-trench (Cell) from the facility's final design media. This performance assessment conceptual model will be used in the development of numerical models for calculating contaminant flow and transport from the facility. It will also include a model for the closure cap above the disposal facility's trench. Sensitivity cases have been defined to assess the impacts of the calculation assumptions concerning the facility's design and waste loading, and the impact of subsidence.

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LIST OF ACRONYMS

BNI	Bechtel National Inc.
BV	bulk vitrification
CDN	composite drainage net
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal regulations
DOE	U. S. Department of Energy
EIS	environmental impact statement
HDPE	high-density polyethylene
HLW	high level waste
HSW	Hanford Solid Waste
IDF	Integrated Disposal Facility
ILAW	immobilized low-activity waste
LAW	low-activity waste
LCRS	leachate collection and recovery system
LDR	land disposal restriction
LDS	leak detection system
LLW	low-level waste
MLLW	mixed low-level waste
NRC	Nuclear Regulatory Commission
PA	performance assessment
PEIS	Programmatic Environmental Impact Statement
PUREX	Plutonium-Uranium Extraction (facility)
RCRA	Resource Conservation and Recovery Act
TRU	transuranic
WM	Waste Management
WTP	Waste Treatment Plant

CONVERSION FACTORS FOR SI AND NON SI UNITS

To convert Column 1 into Column 2, multiply by	Column 1 SI Unit	Column 2 SI Unit	*To convert Column 2 into Column 1, multiply by*
	Length		
0.621	kilometer, km (10^3 m)	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
3.28	meter, m	foot, ft	0.304
1.0	micrometer, µm (10^{-6})	micron, µ	1.0
3.94×10^{-2}	millimeter, mm (10^{-3})	inch, in.	25.4
	Volume		
35.3	cubic meter (m^3)	cubic foot, ft^3	2.83×10^{-2}
3.53×10^{-2}	liter, ($10^{-3}m^3$)	cubic foot, ft^3	28.3
6.10×10^4	cubic meter (m^3)	cubic foot, ft^3	1.64×10^{-5}
	Yield and Rate		
2.24	meter per second, m s	mile per hour	0.447
3.28	meters per second	ft per second	3.048×10^{-1}

1.0 INTRODUCTION

The *Hanford Immobilized Low-Activity Tank Waste Performance Assessment* (Mann et al. 2001) was issued in 2001 to provide the formal performance assessment in support of the eventual disposal of immobilized low-activity (ILAW) tank waste at Hanford. The analyses at that time used two performance assessment (PA) conceptual facility models (Puigh 1999) based on early project planning and a conceptual design was developed for a new disposal facility for the low-activity tank waste (Pickett 1998). Since the issuance of this performance assessment in 2001 there has been an evolution in the planning for this proposed disposal action that has impacted facility design:

- The scope of the disposal action has been expanded to include low-level waste (LLW) and mixed low-level waste (MLLW) (DOE 2004), and
- The DOE is considering other supplemental technology waste forms for the disposal of Hanford tank wastes (Certa 2003)

The Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (HSW EIS) (DOE 2004) has investigated the options for disposing of anticipated quantities of LLW, MLLW, ILAW, and WTP melters at the Hanford site. The DOE preferred alternative is to dispose of newly generated LLW, MLLW, ILAW, and Waste Treatment Plant (WTP) melters in a new modular facility near PUREX. This disposal option would include Hanford generated wastes and could also include LLW and MLLW from currently approved off-site generators, and LLW and MLLW from other DOE off-site generators consistent with the Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE 1997). This new disposal facility would include a RCRA-compliant liner and a leachate collection/leak detection system. It would eventually be capped with a modified RCRA Subtitle C Barrier.

Under the River Protection Project Plan (Certa 2003), the DOE-ORP is considering the use of supplemental Hanford tank waste treatment technologies to support the timely closure of the Hanford waste tanks by 2028. Under this planning WTP Supplemental technology and non-WTP supplemental technology waste forms may also be identified for disposal within the IDF.

The purpose of this report is to provide a description of the Integrated Disposal Facility and various waste packages based on the latest information. This information will be used in the next performance assessment to support the development of models used to assess the overall system performance in meeting established performance objectives. This performance assessment is currently scheduled to be issued in 2005. Data on the facility design will be taken from the Integrated Disposal Facility (IDF) Design Drawing Set (Dehner 2004a) and the detailed design specifications (Dehner 2004b). Data on the waste form will be taken from the current planning and contract requirements. Data on the engineered barriers will be taken from the current version of the disposal facility closure plan (Burbank 2002). Operational information associated with waste loading into the IDF was provided by the IDF project staff.

2.0 DISPOSAL FACILITY DESIGN

The Integrated Disposal facility (IDF) will consist of an expandable lined landfill located in the 200 East Area on the Hanford site. The landfill will be divided lengthwise (north-south orientation) into two distinct Cells, one for the disposal of low-level radioactive waste and the other for the disposal of mixed waste. This report section describes the location of the IDF and its design features pertinent to the performance assessment activities.

2.1 LOCATION

The proposed location for the IDF is on 170 acres of vacant land, southwest of the PUREX Plant in the 200 East Area. The location of the IDF is at the immobilized low-activity waste (ILAW) site that was chosen (Rutherford 1997) for the following three reasons (Shord 1995):

- The location is near existing tank farms
- Unused land is available
- The location is inside the fenceline of the 200 Areas.

To better utilize the original ILAW site to dispose of all of Hanford's non-CERCLA wastes, the Hanford DOE Field Managers considered the site for the disposal of all such waste. This location is the preferred disposal site identified in the HSW EIS (DOE 2004) for the disposal of future solid waste and ILAW. Figure 2-1 shows the proposed location for the IDF. The IDF is located in the southern portion of the 200 East Area. The shaded area indicated by the TSD Boundary label represents Cell 1. The rectangular area to the right represents Cell 2.

The current IDF design (Dehner 2004a, b) has the trench located towards the southern end of the IDF site. The southern location avoids conflicts with existing utilities in the northern portion of the ILAW site. The IDF project site boundary and location of the trench are shown in Figure 2-2. The IDF project site boundary is taken from H-2-830826 (Dehner 2004a-1). The location of the IDF trench within the site boundary is based on the location of the north-west corner of the trench bottom given in drawing H-2-830827 (Dehner 2004a-2) and the dimensions of the trench given in drawing H-2-830832 (Dehner 2004a-3). The north-south length of the trench bottom is 422.1 m (1385 ft). This dimension was calculated to provide sufficient trench volume to accommodate 900,000 m^3 of waste. The actual length will depend on the waste loading. Figure 2-2 shows the relative location of the IDF trench within the IDF project site boundary in Hanford Site Coordinates. The Hanford Site coordinates defining the top of the IDF trench are given in Table 2-1. These coordinates correspond to the trench area defined by its operational layer at a nominal height of 13.2 m above the trench bottom and represents the top surface area for the IDF trench for an assumed length of 501.4 m (1645 ft) (based on accommodating 900,00 m^3 of waste).

Figure 2-1. Integrated Disposal Facility Location on the Hanford Site

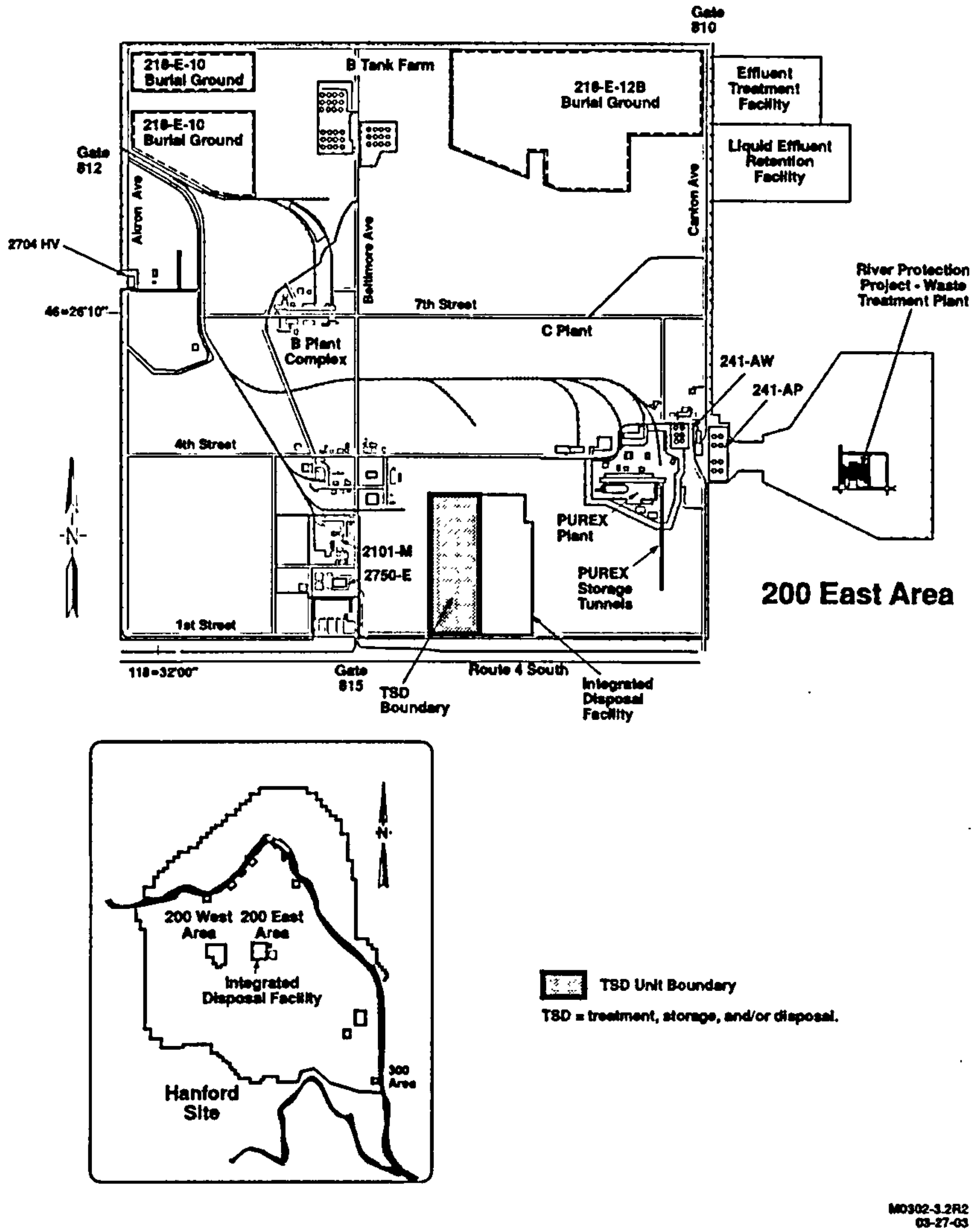


Figure 2-2. IDF Trench Location within Project Boundary

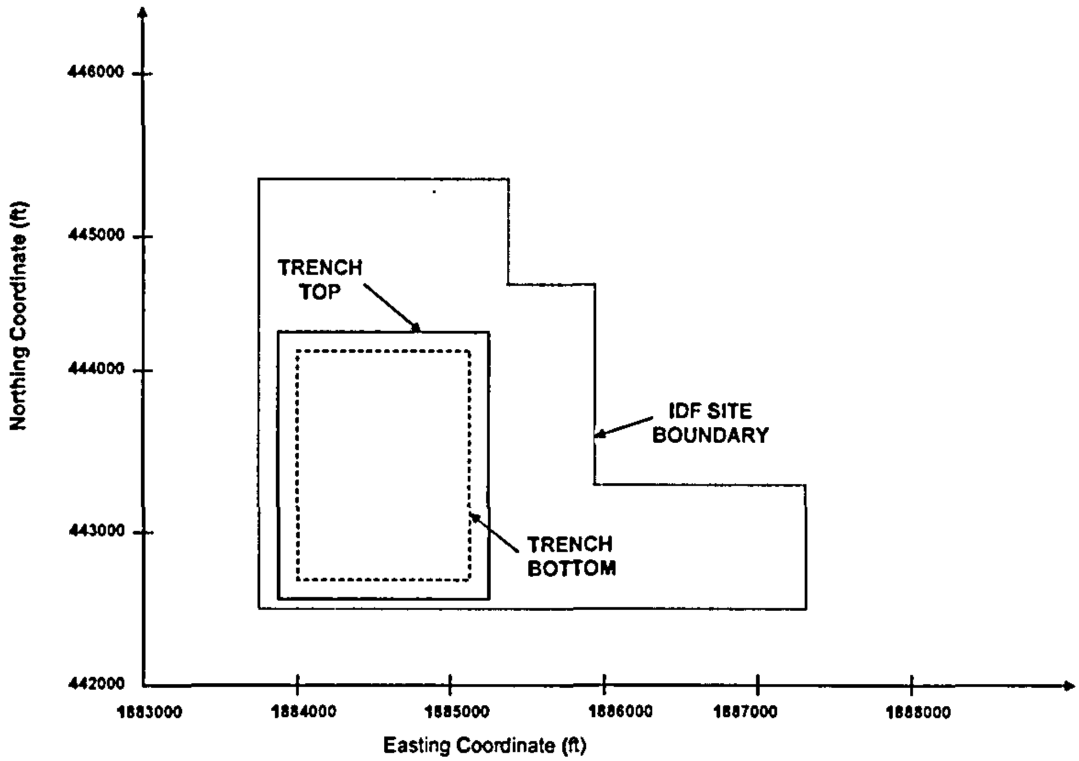


Table 2-1. Hanford Site Coordinates for the IDF Trench Mid-Plane

Top of Trench H-2-830827, Rev 0		
Easting (ft)	Northing (ft)	Location
1883878	442585	SW
1883878	444230	NW
1885223	444230	NE
1885223	442585	SE

2.2 FACILITY DESIGN

This section provides the salient features of the IDF design that are important to the IDF performance assessment activity.

2.2.1 Trench Geometry

The IDF will consist of a lined landfill, approximately 410 m (1345 ft) wide by approximately 501 m (1645 ft) in length by up to 13.2 m (43.3 ft) deep. The landfill is separated into two separate cells that are each 205 m wide by approximately 501 m in length. Each cell is designed to meet the RCRA liner requirements with leachate collection and leak detection systems. The current closure planning (Burbank 2002) is to cover the landfill with a modified RCRA Subtitle C barrier.

The IDF trench will be constructed on the ILAW disposal site. Figure 2-3 (based on drawing H-2-830827, [Dehner 2004a-2]) shows the proposed location of trench within the disposal site. The trench horizontal dimensions are depicted in Figure 2-4 (based on drawing H-2-830832, [Dehner 2004a-3]). The IDF trench internal dimensions, based on the top of the operational layer, are 330.7 m wide at the bottom of the trench and 410 m wide at the top of the trench. The trench side slopes have a 3:1 slope (3 m horizontal to 1 m vertical change). The length of the trench (in the north-south direction) will be sized to accommodate the waste disposed in the IDF. The north-south cross section shown in Figure 2-4 is for the initial IDF (Phase 1) construction. The operations volume within the IDF has a height of 13.2 m (43.33 ft) (based on Drawing H-2-830834 [Dehner 2004a-4]).

2.2.2 Leachate Collection and Recovery System (LCRS) and Leak Detection System

Figure 2-5 (based on H-2-83029 [Dehner 2004a-5]) shows the location of the sumps for the leachate collection and recovery system (LCRS). The LCRS is a system of liners, drainage gravel layers and piping that will collect any liquids captured on the primary liner and route these liquids to a sump location within the trench. The LCRS also includes pumps for removing these leachate liquids from the sump area and storage tanks for the temporary holding of these liquids prior to their disposal.

The trench is provided with a RCRA compliant primary and secondary liner as depicted in Figure 2-6. Beneath both the primary and secondary geomembrane liners is a 0.9-m admix layer. The prepared subgrade material beneath the admix liner is assumed to be composed of backfill material (see Section 2.2.5). The specification for the 0.9 m operation layer is provided in Section 2.2.5.

The leachate collection and recovery system (LCRS) drainage gravel provides the drainage path for the bottom liner (leachate) collection systems associated with this RCRA-compliant disposal facility (see Figure 2-6). Both the primary and secondary drainage layers utilize a geocomposite drainage layer on top of high-density polyethylene (HDPE).

A 12-in. diameter, LCRS slotted pipe is located along the north-south centerline of each cell (see Figure 2-5 [based on Drawing H-2-830829 (Dehner 2004a-5)]). This pipe connects to the LCRS sump at the north end of each cell. The LCRS riser pipes contain the pumps and provide a pathway for removing the leachate from the bottom of the trench to storage tanks. A leak detection system is also installed under the entire primary liner to collect and remove any leachate moving below the primary geomembrane (see Figure 2-5).

A secondary leak detection sump will be constructed beneath each IDF leak detection sump [see drawing H-2-830848 (Dehner 200a-6)]. This secondary leak detection sump system effectively represents a redundant Leak Detection System (LDS) installed under the IDF LDS sump. The secondary leak detection sump will consist of a composite drainage net (CDN) drainage layer, a 60-mil high density polyethylene (HDPE) geomembrane liner and an operations layer to provide a good foundation for the admix liner. The CDN drainage layer and geomembrane liner will extend under the entire base and side slopes area of the IDF LDS sump. The CDN drainage layer is designed to conduct flow to a perforated HDPE collection and riser pipe located at the base of the secondary leak detection sump for collection/detection purposes. The pipe will be surrounded by coarse-grained aggregate material which will allow liquids to flow to the pipe. The riser pipe will provide access to the secondary leak detection sump for liquid depth measurements and for a low-flow pump.

Each cell has a sump located at the north bottom of the trench at the north-south centerline of each cell. The materials comprising the leachate collection system along the bottom of the trench are sloped such that there is a 1% downward slope from south to north in these materials. Also, within a given east-west cross-section of the trench, the leachate collection system materials along the bottom of the trench are arranged with a 2% downward slope towards the centerline of each cell. This layout of the leachate collection system is designed to facilitate the flow of leachate to the collection sites located at the north end of the trench along the centerline of each cell.

2.2.3 Trench Operational Area

The trench operational area is defined as the region within the IDF trench where the waste packages will be placed for disposal. The IDF trench is assumed to include backfilled soil around and on top of the waste containers in the facility. The soil has been included in this concept for the following three reasons:

- For structural support
- To wick moisture away from the waste containers
- To provide radiation shielding for the facility workers.

Because the trench walls have a fairly shallow slope (3 m run for every 1 m rise) each successive vertical layer of waste can be increased in both length and width.

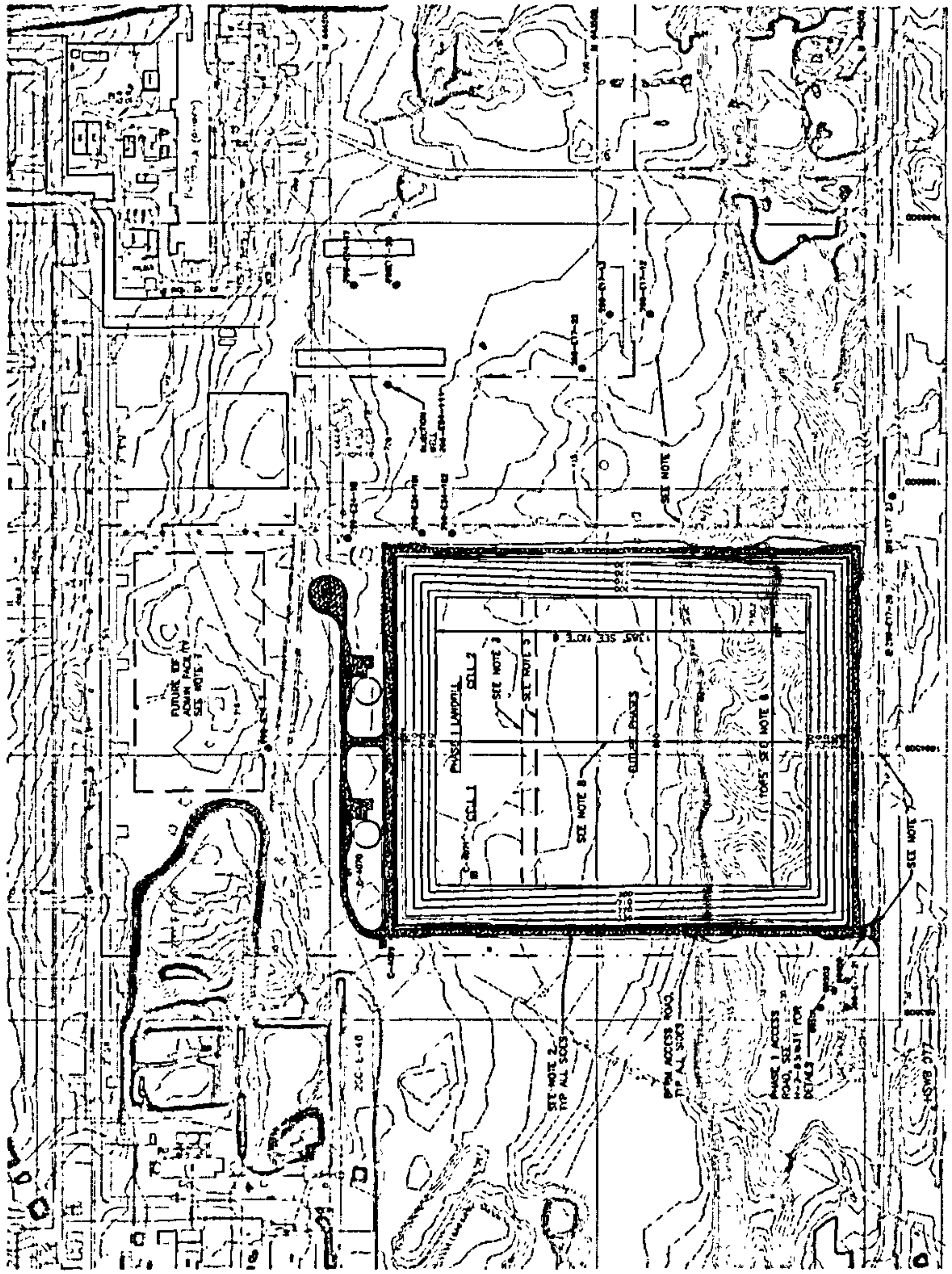
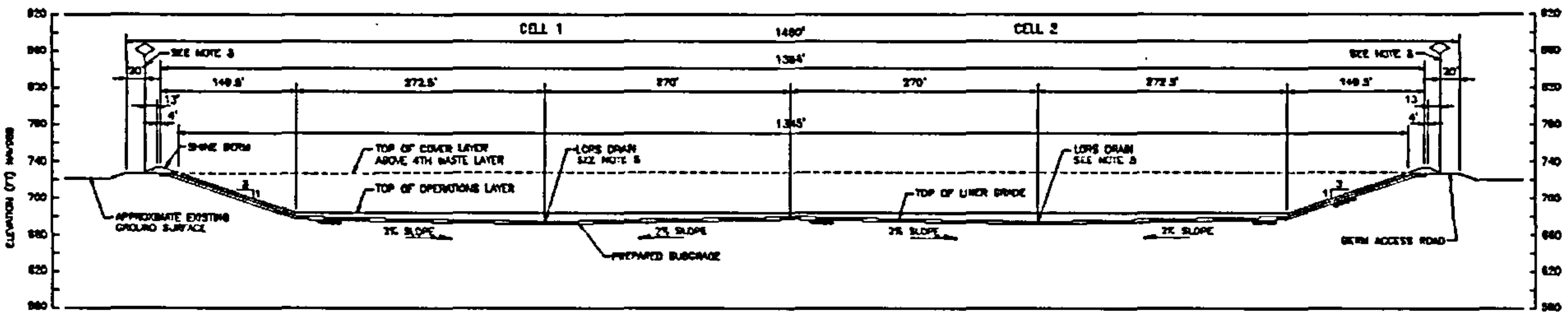


Figure 2-3. Layout of the IDF Facility Within the Disposal Site

Figure 2-4. IDF Trench Cross-Section Dimensions

East – West Cross-Section



North – South Cross Section (Phase 1)

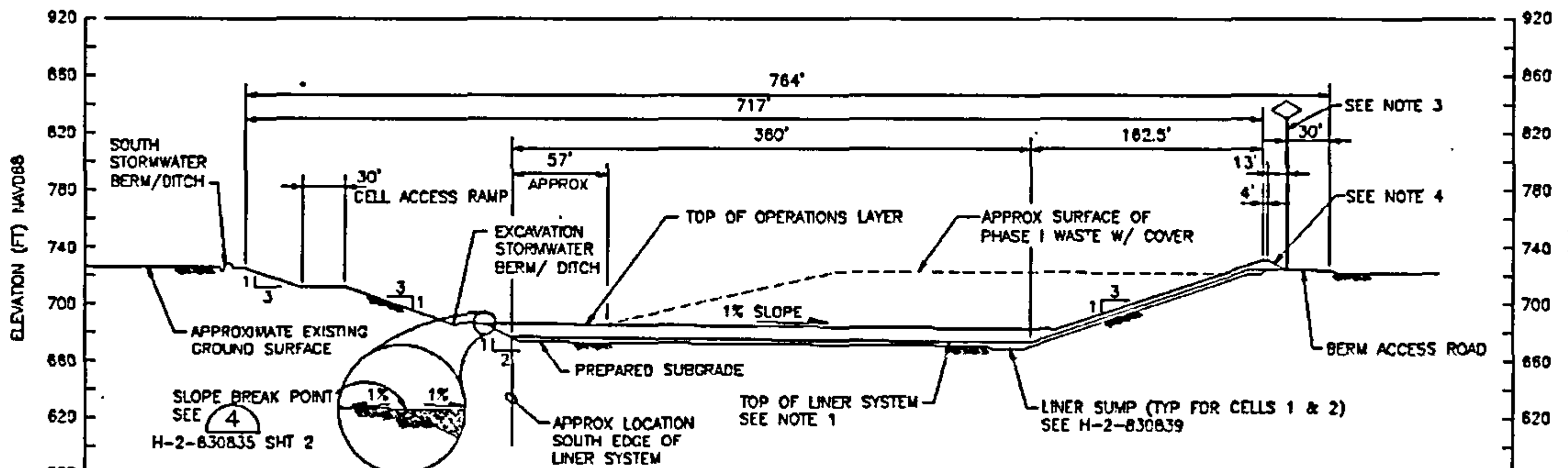


Figure 2-5. IDF Leachate Collection and Recovery System

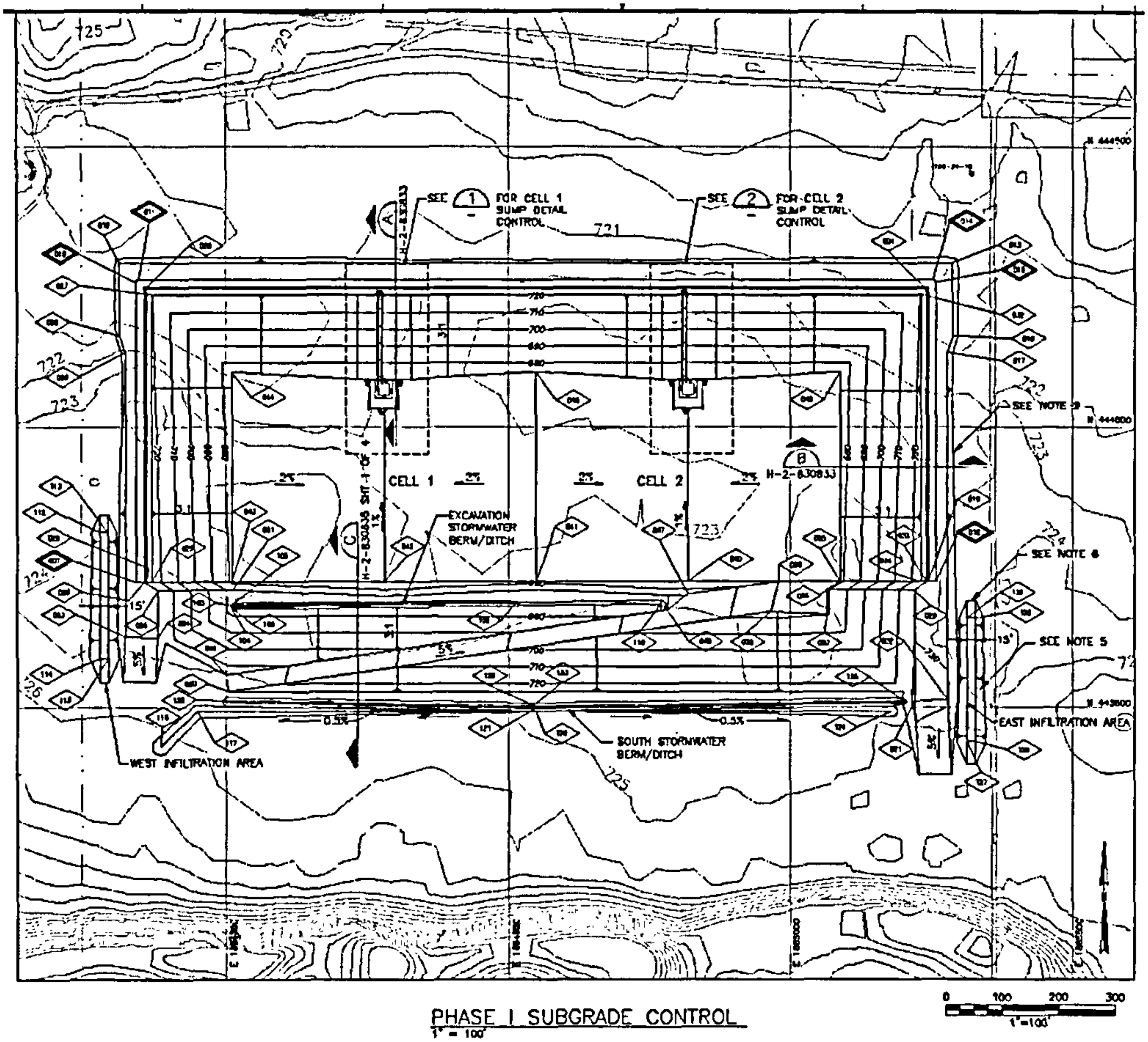
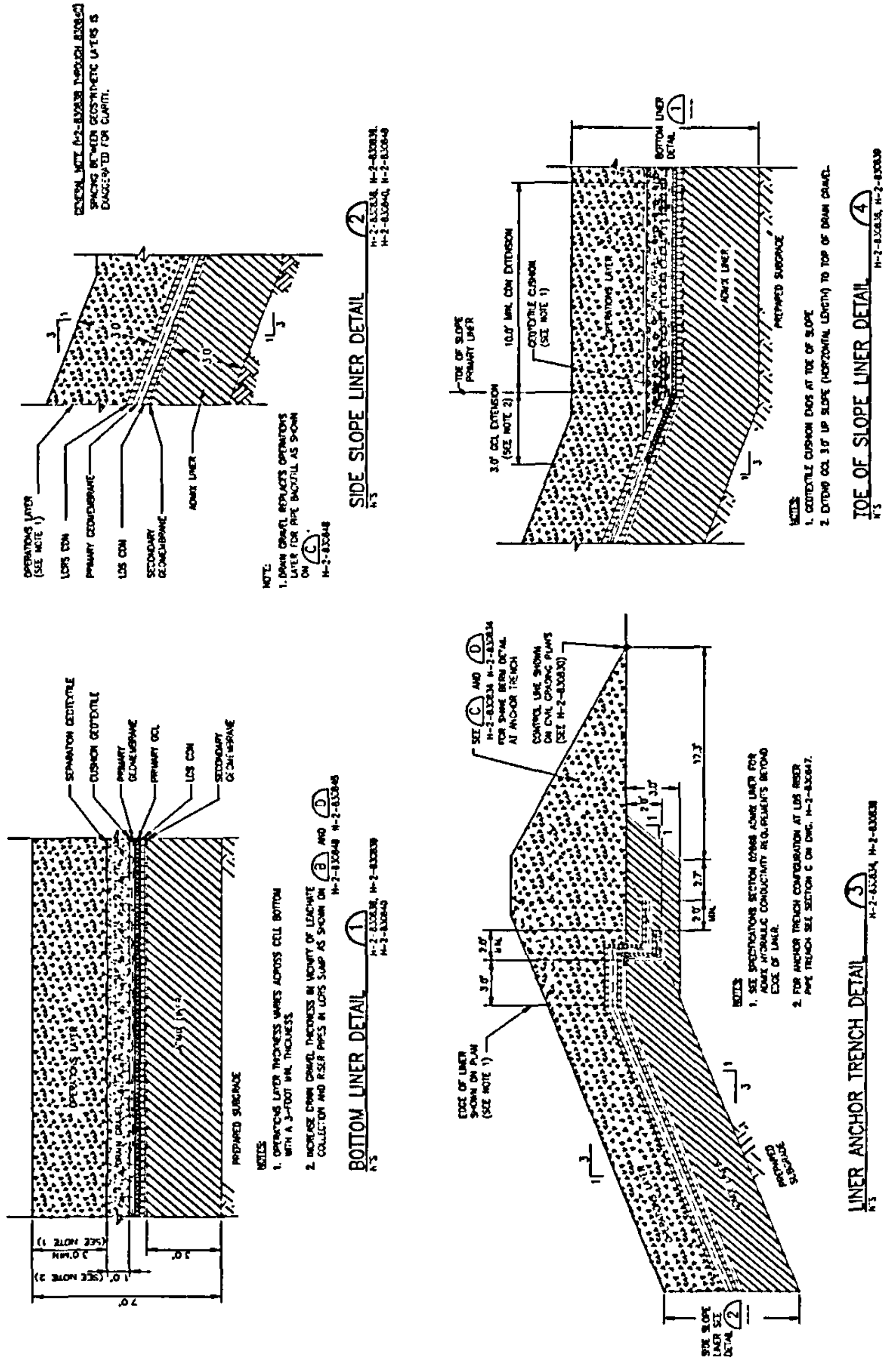


Figure 2-6. IDF RCRA Compliant Liner Details



2.2.4 RCRA Surface Barrier

Above the IDF trench will be a surface barrier designed to minimize physical intrusion and recharge. This surface barrier has not yet been designed for the IDF. Beneath the surface barrier, a sand-gravel capillary break is assumed that will divert any moisture that may come through the surface barrier away from the trench. These two barriers implement the goal of minimizing the amount of water that enters the trench. The barrier is assumed to be thick enough to ensure the depth of the waste packages within the trench is at least 5 meters below the top surface of the barrier. This minimum depth is required by NRC rules (10 CFR 61) for the ILAW waste form. The extent of the barrier beyond the surface edge of the trench liner is assumed to be 6 meters (Burbank 2002). The current preconceptual design for the surface barrier has a modified RCRA-compliant subtitle C barrier with a 5% slope for the asphalt layer and a capillary break beneath the asphalt layer (Burbank 2002). The slope of the surface layer is designed to be 2%. (See Section 5.0 for additional details on the RCRA surface barrier.)

2.2.5 Trench Materials

The material specifications for the materials comprising the IDF trench construction are provided in Integrated Disposal Facility (IDF), Detailed Design: Specifications (Dehner 2004b). Table 2-2 summarizes the specifications for the materials important to the environmental performance of the IDF.

The materials used for backfill around the waste packages as they are placed into the IDF will most likely be native sand material. For the 2005 IDF PA this backfill material is assumed to be equivalent to the operations layer material listed in Table 2-2. Its corresponding hydraulic properties are assumed to be equivalent to the backfill properties provided in Meyer et al. (2004). Similarly, its geochemical properties are assumed to be equivalent to the backfill properties provided in Krupka et al. (2004).

Table 2-2. IDF Material Specifications

Material	Relevant Dimensions	Specification (Dehner 2004b)
Earthfill	n.a.	Excavated material from excavation or designated borrow site; free from rocks greater than 4 inches in the greatest dimension; free from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials
Structural Fill	n.a.	Conform to the requirements of Section 9-03.9(3) Crushed Surfacing-Base Course.
Operations Layer	minimum 3-foot thick	Meet earthfill requirements; have a maximum of 25% by weight passing through No. 200 U.S. sieve; maximum particle size of 2 inches
Drain Gravel	minimum 1-foot thick	Conform to the requirements of Section 9-03.12(4) of the Standard Specifications except material shall be subrounded to rounded gravel (crushed rock and angular gravel shall not be allowed)
Geotextiles Type 1 - separation	6 oz/yd^2	needle punched polypropylene
Geotextiles Type 2 - cushion	12 oz/yd^2	needle punched polypropylene
Composite Drainage Net	n.a.	geonet - high density polyethylene (HDPE) manufactured by extruding two crossing strands to form a bi-planer drainage net structure; Type 1 geotextile thermally bonded to each side of the geonet.
Geomembranes	60-mil nominal thickness	unreinforced, high density polyethylene (HDPE); textured on both sides
Admix Layer	permeability $\leq 1\text{x}10^{-7}$ cm/s	Base soil mixed with 12 % (min.11%-max 14%) by dry weight bentonite; base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious materials rocks greater than 1 inch in dimension shall not comprise more than 2% by weight of the base soil; shall have a 20% minimum passing No. 200 U.S. sieve; Bentonite shall be Bara-Kade 90, manufactured by Bentonite Performance Materials, Inc., or approved equivalent.
Geosynthetic Clay Liner	permeability $\leq 5\text{x}10^{-9}$ cm/s	Bentonite shall be sodium montmorillonite clay encapsulated in polypropylene geotextile (needle punched); non-woven components have a nominal mass per unit area of 6 oz/yd^2

3.0 TYPICAL WASTE PACKAGE DESIGNS

The following waste forms may be disposed in the IDF based on current planning: ILAW (WTP LAW Glass), WTP spent HLW and LAW melters, WTP supplemental technology waste form, non-WTP supplemental technology waste form, solid LLW and solid MLLW. This section describes the waste package geometries associated with each waste form.

3.1 WTP LAW GLASS WASTE PACKAGE DESIGN

The physical, chemical, and radiological properties of the waste at the time of disposal have not been completely determined. The WTP ILAW glass waste form is expected to be contained in right circular, steel cylinder containers (1.22 m diameter by 2.29 m tall) based on the BNI contract (see DOE/ORP 2000). The waste package volume is 2.55 m^3 (90.0 ft^3). The WTP LAW glass container is assumed to be filled to 85% by volume with waste glass. Additional filler material will be added so that the WTP LAW glass container is at least 90% full. Given the geometry of the WTP ILAW glass container that necks near the top, the corresponding LAW glass height in the container is estimated to be 2.0 m. The estimated WTP ILAW glass volume held by each WTP ILAW glass waste package is $0.85*2.55\ m^3 = 2.17\ m^3$. The WTP ILAW glass density is 2.6 MT/m^3 (Kirkbride et al. 2003). The number of WTP ILAW glass waste packages disposed in the IDF will depend on the amount of WTP ILAW glass produced (see Puigh et al. 2004).

3.2 WTP SPENT MELTER PACKAGE DESIGNS

The HLW and LAW melter radiological and physical characteristics have not been finalized. The following assumptions have been made concerning the quantity of waste material remaining in the spent melters, their dimensions and overpack design.

From Peters (2002) the size of the original melt tank cavity is 2.44 m L x 1.52 m W x 1.17 m H (96 inches L x 60 inches W x 46 inches H). With brick corrosion and soak-in glass, the tank size grows horizontally by 35.6 cm (14 inches) (because both side walls recede) and vertically by 5 inches. The maximum final glass tank size is therefore 2.79 m L x 1.88 m W x 1.30 m H (110 inches x 74 inches x 51 inches). Upon cooling, only the glass height is assumed to change from 1.30 m (51 inches) to 1.09 m (43 inches). Therefore the final maximum glass volume remaining in a HLW melter is 5,753 L (351,378 inches^3). The glass density (cold) is 2.6 kg/L; therefore, the maximum glass mass is 1.50×10^4 kg.

From Duratek LAW melter drawings the size of the original melt tank cavity is 4.93 m L x 2.03 m W x 0.76 m H (194 inches L x 80 inches W x 30 inches H). With brick corrosion and soak-in glass, the tank size grows horizontally by 71.2 cm (28 inches) and vertically by 35.6 cm (14 inches). The final glass LAW tank size is therefore 5.64 m L x 2.74 m W x 1.12 m H (222 inches x 108 inches x 44 inches). Assuming the hot density of the LAW glass is 2.2 kg/L, the LAW cold glass density is 2.6 kg/L, and all the shrinkage occurs in the height dimension, then the final LAW glass height is 0.97 m (37 (=44*2.2/2.6) inches). Therefore, the final maximum glass volume remaining in a LAW melter is 14,524 L (887,112 inches^3) or 3.78×10^4 kg.

The melter Overpacks are currently designed as carbon steel containers that provide the necessary shielding, contamination control, and structural rigidity to allow direct burial of the spent melters as MLLW (Zuberi and Lowe 2003). Table 3-1 summarizes the current melter overpack design envelopes.

Table 3-1. Melter and Melter Overpack Characteristics

Melter Type	Height [1]	Length [1]	Width [1]	Surface to Volume Ratio	Overpack Weight
HLW	4.38-m (172-in)	5.29-m (208-in)	5.29-m (208-in)	1.215 m^{-1}	263 MT (580,000 lbs) (Zuberi and Lowe 2003)
LAW	4.86-m (190-in)	6.79-m (262-in)	9.38-m (367-in)	0.9295 m^{-1}	363 MT (800,000 lbs) under consideration per Zuberi and Lowe (2003)

1 The LAW and HLW melter dimensions include the melter overpack.

A preliminary shielding assessment for the HLW melter indicates a steel shielding thickness of 8 inches for the overpack is necessary to maintain the external doses to less than 2.5 mrem/h (assuming no decontamination of the HLW melter) (Woodruffe 2002). Planning for the disposal of the LAW melters is still under development. For this risk assessment, we have assumed that a 1-inch thick steel rectangular overpack is used for the LAW melters. For this risk assessment both the LAW and HLW melters are assumed to be grouted into their respective overpacks.

The number of spent melters disposed in the IDF will depend on the degree to which supplemental technology waste forms are used. Estimates for the number of spent melters disposed in the IDF are provided in Puigh et al. (2004).

3.3 LOW-LEVEL AND MIXED LOW-LEVEL WASTE PACKAGE DESIGNS

The waste package designs that will be used to dispose LLW and MLLW in the IDF are not known. The Hanford Solid Waste Burial Grounds has had experience with the disposal of many different waste package geometries during its operation. Two waste package designs, 55-gallon drums and waste burial boxes, have been used at the Hanford Solid Waste Burial grounds.

The 55-gallon drum waste package has nominal dimensions of 0.60 m diameter by 0.884 m in height. It is typically fabricated from steel and may be either painted or galvanized. The waste volume contained in a standard 55-gallon drum is nominally 0.208 m^3.

The waste burial box has nominal dimensions of 1.22 m [L] x 2.44 m [W] x 1.22 m [H] (4 ft [L] x 8 ft [W] x 4 ft [H]). It is typically fabricated from steel. The waste volume contained in this waste package is nominally 3.62 m^3.

The waste packages accepted into the Hanford Solid Waste Burial Grounds have been categorized within the SWIFT report (Barcot 2003) into the following package sizes: small boxes (volume less than 3.95 m^3, MB-V with volumes = 3.95 m^3, medium boxes (volume between 3.95 m^3 and 15 m^3), large boxes (volumes between 15 and 28.3 m^3), extra large boxes (volumes greater than 28.3 m^3) and SWBs with volumes = 2.1 m^3. Estimates for the volume of LLW and MLLW disposed in the IDF are provided in Puigh et al. (2004).

The void fraction for the LLW and MLLW loaded into these waste package geometries is required to be less than 10% (Girres 2004). However, there are currently no requirements addressing compressibility of these waste packages. Therefore, subsidence can be a concern.

The typical process for treatment of hazardous materials to meet Land Disposal Restrictions (LDR) is to grout the associated MLLW prior to disposal. Also, LLW may be grouted if the activity is above Category 1 levels.

3.4 SUPPLEMENTAL TECHNOLOGY WASTE PACKAGE DESIGNS

The waste form for the WTP supplemental technology waste stream is not known. For the 2005 IDF performance assessment we have assumed that all the WTP supplemental technology waste is processed by the bulk vitrification (BV) process. The BV waste package geometry has not been finalized. The preliminary waste package design assumes a rectangular box having dimensions of 2.4 m (H) x 7.5 m (L) x 3.0 m (W) (8 x 24' x 10') (Leonard 2004). We have assumed the waste height within the package is 2.8 m until better information is provided. Estimates for the number of BV waste packages disposed in the IDF are provided in Puigh et al. (2004).

3.5 NON-WTP SUPPLEMENTAL TECHNOLOGY WASTE PACKAGE DESIGN

The waste form for the non-WTP supplemental technology waste stream is not known. For the 2005 IDF performance assessment we have assumed that all the non-WTP supplemental technology waste is processed by the bulk vitrification process. See Section 3.4 for appropriate waste form parameters for this waste stream. Estimates for the volume of non-WTP supplemental technology waste packages disposed in the IDF are provided in Puigh et al. (2004).

4.0 OPERATIONAL CONSIDERATIONS – WASTE LOADING

The current operational plans for the IDF are to fill the trench in stages. For this performance assessment we have assumed the ILAW and MLLW (including melters) would be placed into Cell 1 (1/2 trench width in the East – West direction) and the LLW would be placed into Cell 2 (see Figure 2-5). The trench volume located at +/- 15 ft (4.6 m) from the trench centerline separating Cell 1 and Cell 2 is assumed to not contain any MLLW. The length of the trench southward would be extended, as necessary, to accommodate the near term waste inventories planned for disposal. The inventory estimates for the different waste form and for different inventory cases are provided in Puigh et al. (2004).

The waste package loading for the different waste forms is assumed to consume 40% of the available trench volume within the IDF (Dehner 2004b). For the purposes of this risk assessment the facility closure is assumed to occur in 2046. This date is later than used in the 2001 ILAW PA and was chosen to accommodate the disposal of LLW and MLLW at the IDF site. This date impacts the intruder and air pathway dose estimates for only the short half-life radionuclides. Uncertainties associated with the waste loading include:

- spacing between waste packages for different waste forms
- macro-loading of different waste forms into IDF (i.e., lifts, layers between waste forms, etc.)
- any potential for mixing of different waste forms vertically
- nominal trench space taken by each waste form

Current operational planning for the separation between like waste forms on a given layer (or Lift) are:

- 10 cm (4 inch) minimum separation between WTP ILAW waste packages
- 0.9 m (3 ft) minimum separation between WTP spent melters and Bulk Vitrification waste boxes

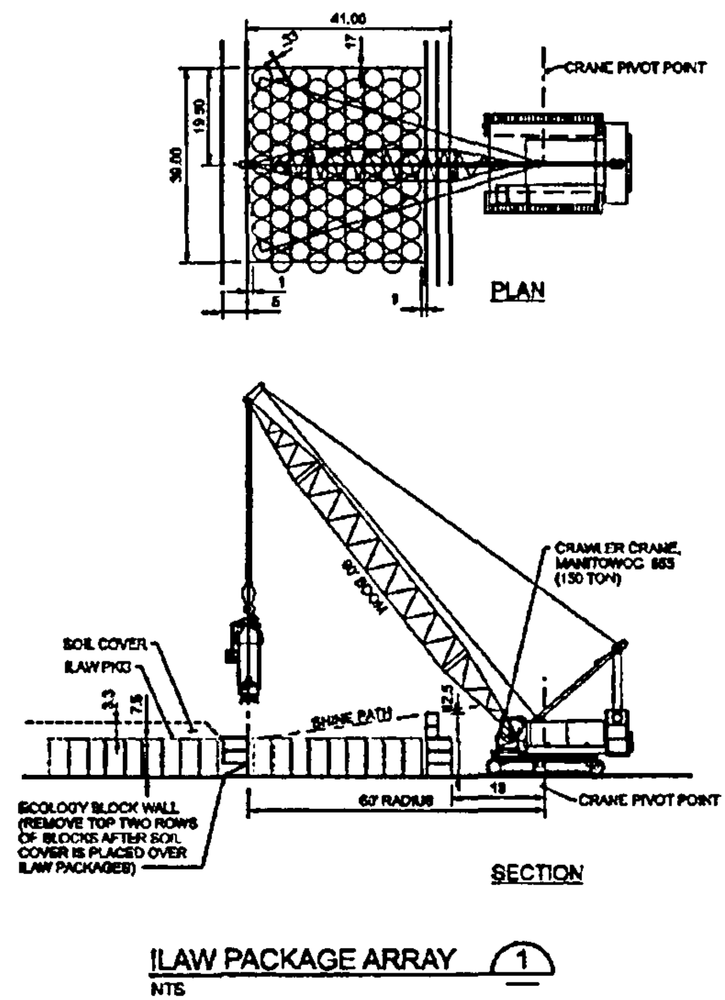
The separation between solid waste (LLW and MLLW) waste packages has not been determined. The IDF cell design assumes a waste volume loading of 40% into the available trench volume (soil to waste ratio of 1.5 to 1) (Dehner 2004b).

The loading of waste into each IDF Cell is assumed to be in layers, called lifts. The planning lift thickness corresponds to the waste stack height (typically 2.3 m) and cover soil layer (typically 1 m). Waste packages with heights less than to slightly greater than 2.3 m (i.e., 2.4 m) would be accommodated into one lift. For example, WTP ILAW, Bulk Vitrification, and some solid waste packages (such as 208 L drums and typical waste boxes) can be accommodated in one lift. Spent melters and large solid waste packages would be accommodated in several lifts. The current planning is to locate spent melters on the bottom lift (Lift 1).

The waste loading plan into the IDF has not been finalized. Currently planning anticipates the loading of similar waste forms into a portion of a given lift. This current planning also anticipates the possibility of different waste forms on top of each other. For the reference calculations examining the release of contaminants from a given waste form in the IDF, the modeling will assume the same waste form stacked on top of each other within the model. Sensitivity cases will explore the impact of stacking different waste forms vertically on top of one another (see Section 7.2.1).

Figure 4-1 shows the planned loading for the WTP ILAW packages in the IDF. The minimum separation between the waste packages is 10 cm (4 inches). The waste packages will be placed in a close pack array as shown in Figure 4-1. The current loading plan limits the width of the array to 9 rows of waste packages. The length of the waste package array is limited only by the size of the Cell. Concrete shield blocks stacked three high (2.5 ft high, each) would remain in the trench at closure. The separation between the shield blocks (5-ft thick) and the waste packages is 1 foot. Therefore the distance between one array of waste packages and the next is 7 feet.

Figure 4-1. Reference Loading of WTP ILAW Waste Packages into IDF



5.0 FACILITY CLOSURE

The closure cap system is an essential part of the overall disposal system. As such, the closure cap system design must be addressed as an integral part of the design for the overall disposal facility system. The closure cap system for the IDF has not been designed. The *Preliminary Closure Plan for the Immobilized Low-Activity Disposal Facility Project* (Burbank 2002) will form the conceptual basis for the IDF.

Under this preliminary closure plan, the current concept for the closure cap is a modified RCRA Subtitle C barrier design. The modified RCRA Subtitle C barrier design is the baseline design for a disposal facility containing not only dangerous waste, but also Category 3 LLW. The barrier is designed to act as a barrier to intrusion and provide hydrologic protection and containment for a performance period of 500 years (DOE/RL 1996). The specific choice of barrier materials, barrier thickness, and degree of capping barrier slope are all still subject to change. They will be tailored to the function and performance requirements for these uppermost layers as the design and performance assessment work progresses. Figure 5-1 shows the initial choice of barrier materials, barrier thickness and degree of capping barrier slope for the ILAW remote handled trenches (Burbank 2002). We have assumed this conceptual design is applicable to the IDF closure cap design.

The modified RCRA Subtitle C barrier will be constructed over the IDF waste packages to ensure a minimum depth below the surface of at least 5 m. A barrier overhang will be used to control potential water infiltration problems at the edges of the barrier. "Barrier overhang" is the terminology used to describe the projection of the functional barrier surface beyond the perimeter of the waste zone. The barrier overhang will extend 6 m (9.7 ft) beyond the edge of the IDF trench. This edge is defined by the surface edge of the secondary trench liner shown in Detail 3 of Figure 2-6 (H-2-830838, Rev. A [Dehner 2004a-7]). Beyond the barrier overhang, the barrier layers above the low-permeability layer(s) will extend further but at a steeper slope of 3:1 (horizontal : vertical) until they reach the existing ground elevation.

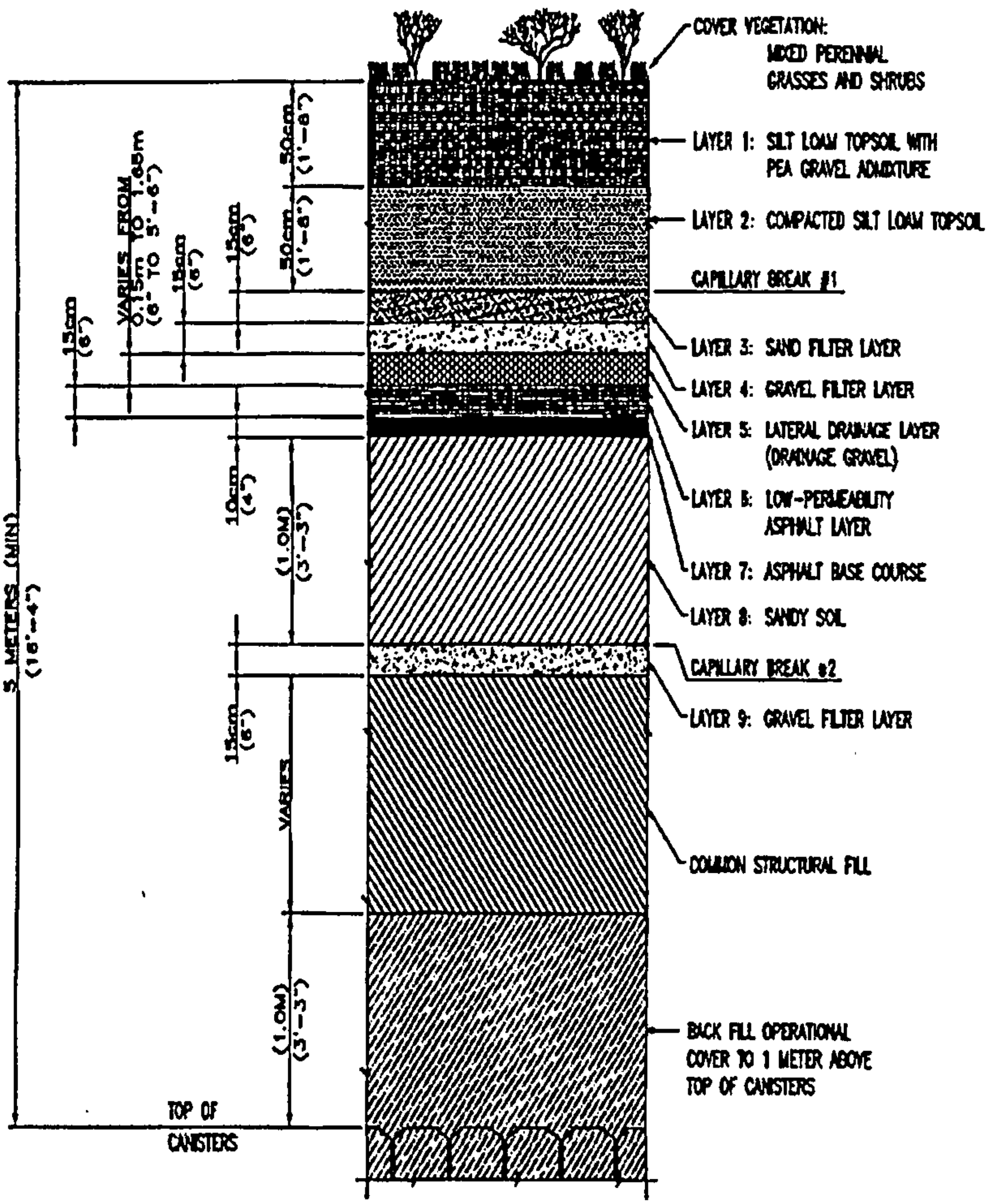
The common structural fill (most likely native sand) will be placed above the IDF trench to provide a 5% slope from the apex of the cap located along the north-south line above the divider between Cells 1 and 2 towards the east and west edges of the IDF trench. A 15-cm thick gravel filter layer is placed over the common structural fill. This layer provides a capillary break for any water reaching this depth. The next layer consists of 1.0 m sandy soil. This sand layer will be smoothed to establish a planar based surface for accurate and controlled placement of the overlying layers. A 10 cm thick asphalt base course will provide a stable base for placing the overlying low-permeability asphalt layer. The 15 cm asphaltic concrete layer will be placed above the asphalt layer. This layer will have a 5% slope. Next, a 15 cm to 4.8 m thick layer of drainage gravel will be laid down. This layer promotes the lateral moisture flow and forms the basis for reducing the surface slope of the cap to 2% for erosion control.

The next task will be installing the second two-part graded filter layer (labeled Capillary Break #1). The lower layer will be a 15 cm thick gravel filter layer. The gravel in this layer will be sized to be compatible with the lateral drainage gravel layer below and the sand filter layer above to prevent fine textures sand from moving downward. A 15 cm sand filter layer will be installed on top of the gravel filter layer. A 50 cm thick layer of compacted topsoil is installed above the sand filter layer. The current recommended material is McGee Ranch silt loam without pea gravel. This layer will be compacted to at least 85% of optimum dry density.

Another 50-cm thick layer is installed above the first topsoil layer and the current recommended material is McGee Ranch silt loam mixed with 15 wt % pea gravel, 2.4 mm to 9.5 mm in diameter, and mixed uniformly. The estimated bulk density for this soil mixture is 1.46 g/cm^3. This top layer will be prepared for planting with mixed perennial grasses, shrubs, and sagebrush.

A fence is proposed to surround the perimeter of the IDF facility. This fence will prevent medium to large animals from accessing the cover.

Figure 5-1. Reference RCRA Cap Design



6.0 PERFORMANCE ASSESSMENT CONCEPTUAL MODEL

The new IDF design will form the basis for the facility PA conceptual model used in the performance assessment calculations scheduled for the 2005 PA. To facilitate these calculations, a PA conceptual model has been developed for the base analysis case. This PA conceptual model incorporates the important design features impacting contaminant transport from the waste product into the far field vadose zone. From this PA conceptual model, numerical models will be developed to conduct the transport calculations for important waste contaminants from the waste form to the far field vadose zone. Other numerical models will be used to calculate the transport of these released waste products through the vadose zone and the groundwater to potential receptors identified in the scenarios for the IDF PA (Mann 1999).

The PA conceptual model identifies the IDF trench geometry and layout, the planned materials of construction, and selected information on the waste packages. Additional information on the materials of construction and the near field material properties pertinent to waste product transport are provided in the near-field data packages (Meyer et al. 2004; Krupka et al. 2004).

Section 2 of this report describes the current status of the new IDF design. To facilitate numerical calculations the trench layout and geometrical dimensions have been simplified. The layout of the IDF trench and its location are shown in Figure 2-2. The figure provides a top view of the trench layout. In the PA conceptual model, the ancillary modifications made to the site to support the loading of the disposal trench and the ancillary equipment and facilities supporting the leachate collection system have been ignored.

Figure 6-1 provides a simplified geometry for the new IDF Cell. In this simplified PA conceptual model, the leachate tanks and sampling ports are assumed to be effectively sealed during closure so that they do not provide any preferential path for moisture influx or contaminant transport. The HDPE layers are ignored in the model since their function as a moisture barrier is assumed to degrade in less than 100 years. The drainage pipes to the leachate tanks are also not included in the model.

The orientation and design for the final closure cap for the new disposal vaults is described in Sections 2.2.4 and 5.0. The closure cap details near the edge of the trench are shown in Figure 6-2. The trench extends 6 m beyond the surface edge of the secondary trench liner extends 10 m beyond the layout of the IDF trench. Note that the closure cap is shaped like an inverted "v" and placed with its apex along the length dimension (north-south) and centered over the IDF trench. The slope of the closure mound outside the area of the closure cap is in a 3:1 slope to the existing ground elevation.

Figure 6-1. IDF Trench PA Conceptual Model

IDF CELL CONCEPTUAL MODEL
REFERENCE IDF CLOSURE CAP

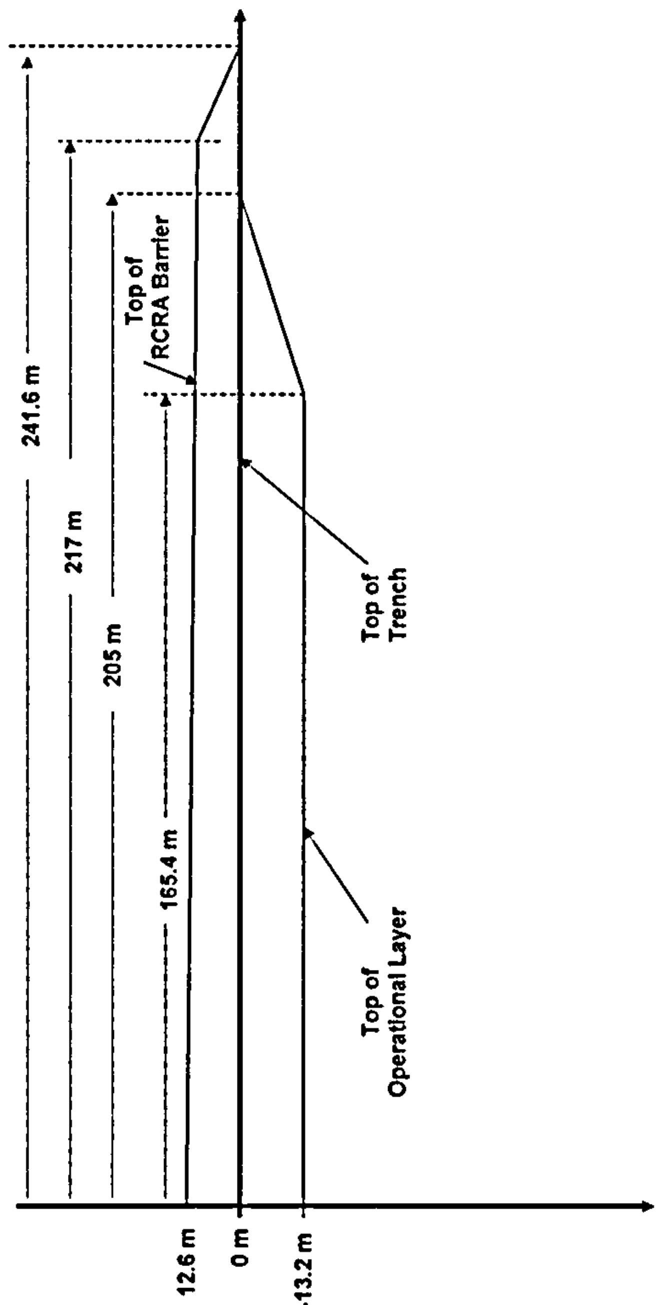
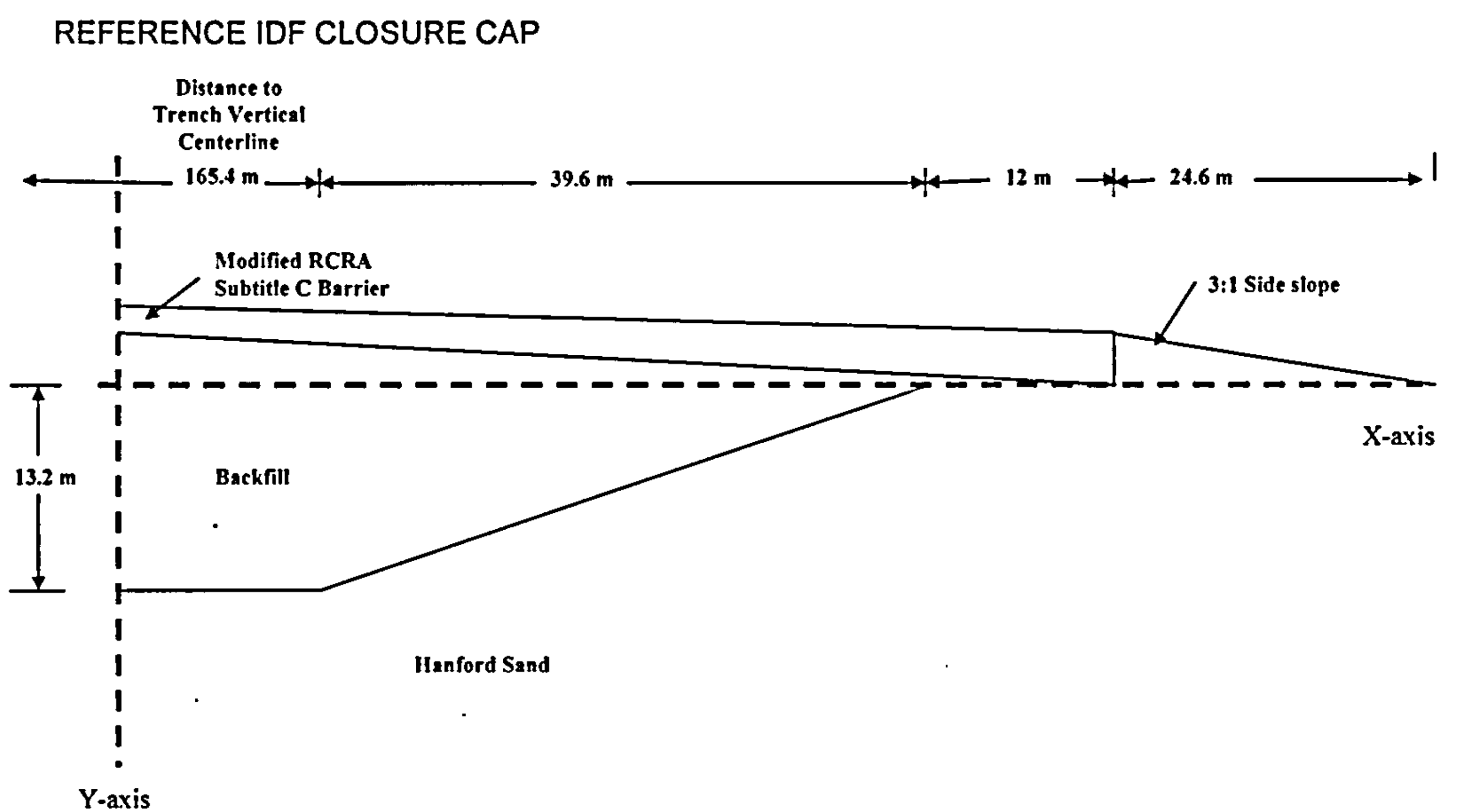


Figure 6-2. Reference Closure Cap Details at Edge of IDF Trench



7.0 FACILITY UNCERTAINTY CASES

A number of assumptions are currently associated with our understanding of the disposal facility. Planning has identified concepts to be used and locations for the disposal of initial waste to be provided by the WTP under contract to the DOE. These designs are not finalized. Also, the closure system to be used for the disposal facilities has not been finalized. Sections 2, 3, 4 and 5 of this report provide the facility parameters to be used in the best estimate calculations for the performance assessment. Section 6 contains the PA conceptual models for the ILAW base analysis case. In this section of the report we define sensitivity cases that may be used to assess the sensitivity of the performance assessment to uncertainties in the facility design.

The major facility uncertainty cases can be grouped into two types: 1) uncertainty associated with facility design and 2) uncertainty associated with facility operational performance.

7.1 FACILITY DESIGN CASES

The following facility design sensitivity cases were investigated in the 2001 ILAW PA: 1) functioning capillary break, 2) side slope impact, 3) adding vertical gravel break, 4) short surface barrier, 5) material fill type within trench, 6) use of concrete walls, 7) various layouts of trenches on the disposal site and 8) use of existing concrete vaults.

For the 2005 IDF PA the following facility design cases have been identified: 1) functioning capillary break beneath the RCRA cap, 2) IDF trench layout within the disposal site, 3) alternate RCRA cap design, 4) different fill type material within the trench and 5) functioning capillary break beneath the trench.

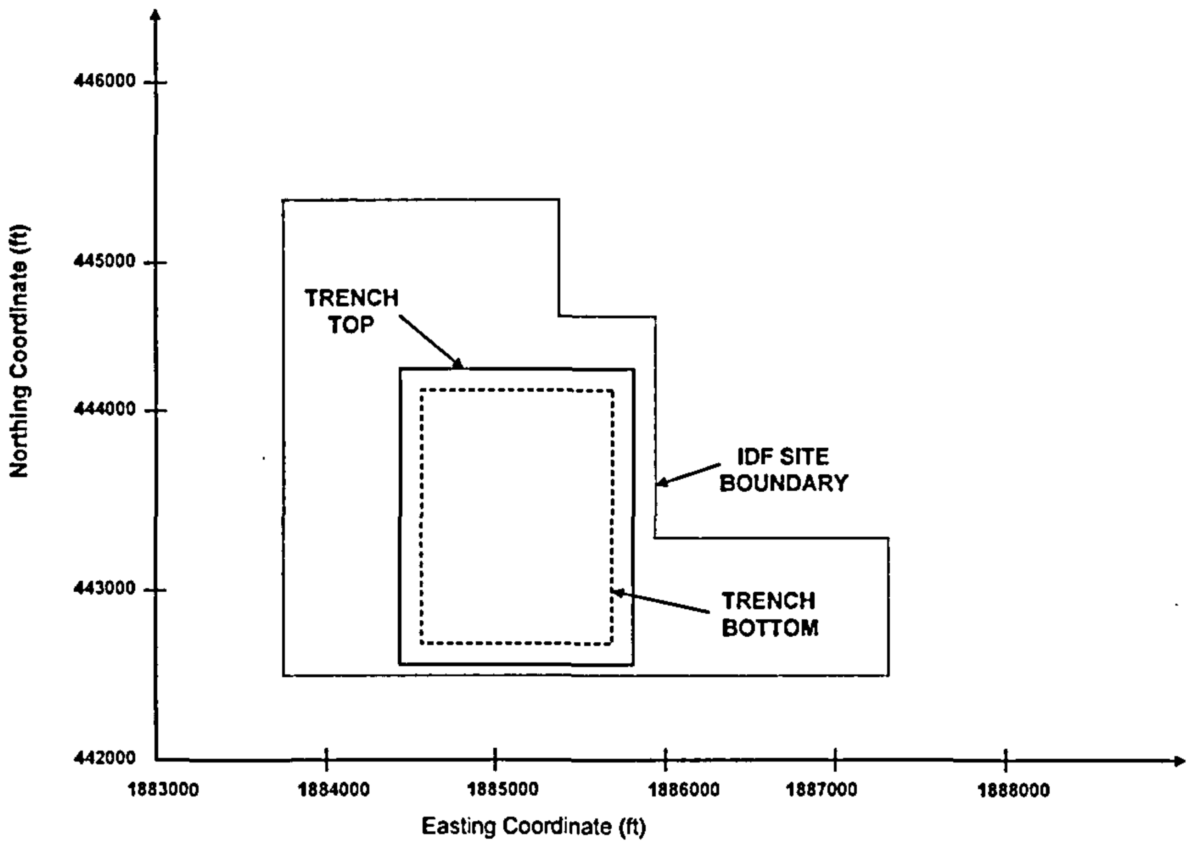
7.1.1 Functioning Capillary Break beneath the RCRA Cap

The current RCRA cap design includes a capillary break comprised of a sand layer over a gravel layer that is beneath the asphalt layer of the RCRA cap. This structure should be relatively impervious for any assumed lifetime for the RCRA cap itself. As in the 2001 ILAW PA (Mann et al. 2001) the sensitivity case will assume this capillary break functions for all time after facility closure.

7.1.2 IDF Layout

The layout for the IDF has been established with the IDF trench located near the southern end of the IDF project site (see Figure 2-2). However, the design layout may change. An alternate orientation could have the IDF trench located at the eastern-most edge of the IDF project site. This could change the well intercept factor associated with contaminant transport from the disposal facility. Figure 7-1 shows a potential alternate location for the IDF trench within the IDF project site boundary.

Figure 7-1. Alternate Layout for the IDF Trench



7.1.3 Alternate RCRA Cap Design

An alternate capillary break design is assumed similar to the RCRA cap design (Burbank et al. 2000) used in the 2001 ILAW PA (Mann et al. 2001). Specifically, the materials identified for the reference cap design are assumed to be the same. The only different is the thickness of the different layers is chosen to be the fixed minimum width so that the asphalt layer has a 2% downward slope (see Figure 7-2). The closure cap details near the edge of the trench are shown in Figure 7-2. The common structural fill (see Table 2-1) will be placed above the IDF trench to provide a 2% slope from the apex of the cap located along the north-south line above the divider between Cells 1 and 2 towards the east and west edges of the IDF trench. A 1.0-m thick gravel filter layer is placed over the common structural fill. This layer provides a capillary break for any water reaching this depth. The next layer consists of 1.0 m sandy soil. This sand layer will be smoothed to establish a planar based surface for accurate and controlled placement of the overlying layers. The layers above the sand layer are made from the same materials as the reference closure cap shown in Figure 5-1. The only difference is that the lateral drainage layer has a fixed thickness of 0.15 m. The top of the closure cap peaks at the centerline of the facility at 8.1 m above surface grade, and slopes down at a 2% grade to where the RCRA cap ends (at

X = 212 m from the IDF trench centerline). The height of the top of the closure cap above ground level is 3.8 m above surface grade. Beyond the end of the barrier, the model represents a 'side slope', consisting of backfill material, out to the right hand side of the model.

7.1.4 Different Trench Fill Material

The reference fill material for the trench is backfill material. The relevant hydrologic and chemical properties are provided in (Meyer et al. 2004) and (Krupka et al. 2004), respectively. The sensitivity case will consider the backfill material to be sand.

7.2 FACILITY OPERATIONAL CASES

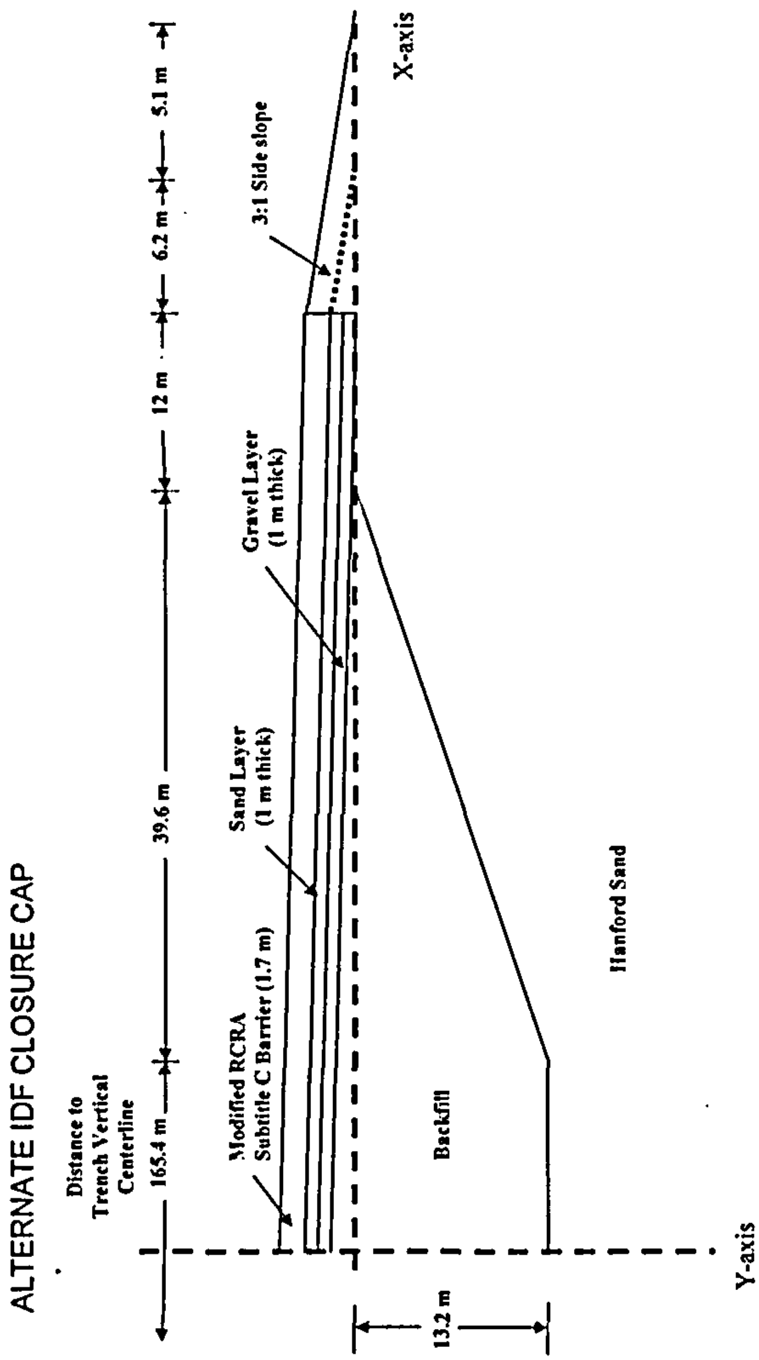
The only facility operational sensitivity cases investigated in the 2001 ILAW PA were associated with the failure of the capillary break (subsidence) and a bathtub effect where the trench soil was assumed to become totally saturated for a period of time. For the 2005 IDF PA the following facility operational sensitivity cases have been identified: 1) alternate waste loading into cells and subsidence (failure of the capillary break) and 2) a functioning capillary break beneath the trench.

7.2.1 Alternate Waste Loading into Cells

The reference case considers the nominal loading of each waste form individually into the trench over a given cross-sectional area of the trench (see Section 4.0). Under this sensitivity case the loading of different waste forms on top of each other is considered. The specific case envisioned assumes MLLW waste is combined with ILAW glass in a given section of the IDF trench.

This case considered the loading of MLLW (grouted) with ILAW Glass. Specifically, the MLLW is assumed to be loaded above the ILAW glass. This case was selected because the glass release rate may be impacted by the pore water chemistry.

Figure 7-2. Alternate Closure Cap Details at Edge of IDF Trench



7.2.2 Subsidence

Subsidence was investigated in the 2001 ILAW PA (Mann et al. 2001) and in the 2002 Annual report (Mann 2002). The results showed the effect on the release from the ILAW glass was bound by the base case where the infiltration rate was assumed to be equal to the recharge at the IDF site, neglecting the impact of the closure cap. The current IDF is significantly larger and can have high local infiltration rates in regions of subsidence that are significantly larger than the infiltration cases due to subsidence that have been investigated thus far. Also, the IDF will contain other waste forms that may be more susceptible for high infiltration rates when compared to ILAW glass. Therefore, a suite of subsidence cases are proposed for the 2005 IDF PA.

Table 7-1 summarizes the subsidence cases proposed for investigation. The subsidence case category includes cases that address the sensitivity of the contaminant transport to subsidence specific parameters. These specific parameters include the location of the subsidence, its depth, and its length. Table 7-1 summarizes the specific ranges of values investigated in this report.

Table 7-1. Subsidence Cases

Case Name	Location[1] (m)	Depth[2] (m)	Length[3] (m)
Loc10	10	0.3	1.0
Loc40	40	0.3	1.0
Loc80	80	0.3	1.0
Loc120	120	0.3	1.0
Loc160	160	0.3	1.0
Dep1	80	0.1	1.0
Dep5	80	0.5	1.0
Dep10	80	0.7	1.0
Bump05	80	-0.05	0.10
Bump3	80	-0.3	0.30
Len05	80	0.3	0.5
Len3	80	0.3	3.0

[1] Distance from apex of trench to start of subsidence depression
[2] Depth of the subsidence depression; negative depth indicates sand/gravel interface moves upward
[3] Effective length of the depression perpendicular to trench axis

The effect of these subsidence cases will be investigated for the different waste forms destined for disposal in the IDF. Currently, the different waste forms include: LLW, MLLW, WTP ILAW, WTP supplemental LAW, and non-WTP supplemental LAW.

7.2.3 Functioning Capillary Break Beneath the Trench

The current IDF design has an effective capillary break beneath the trench operating layer (see Figure 2-6) that includes a 2% slope towards the center of each Cell and a 1% slope towards the two sump pumps located at the north end of each Cell (see Figure 2-5). The base case neglects the effect of this slope. This sensitivity case considers two bounding cases where the capillary break and RCRA cap are not functioning above the trench and all the moisture is constrained to flow towards the sump. The first case assumes there is a small region around the sump where the moisture can escape into the vadose zone beneath the trench. For this case the reference recharge rate is assumed to be channeled through a 2m x 2m hole located at the sump location. The cap above the trench is assumed to be degraded to natural recharge conditions. The second case is similar to the bathtub case investigated in the 2001 ILAW PA (Mann et al. 2001). Under the second case the pore space within the trench is assumed to become completely filled with water. The peak contaminant concentration from each waste form is estimated to be in the pore water. The total released concentration is assumed to instantly enter the groundwater (neglecting transport through the vadose zone).

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Subcontractor Calculation Review Checklist

Subject: Disposal Facility Data for the Hanford IDF PA-RPP-20691, Rev. 0

The subject document has been reviewed by the undersigned.
The checker reviewed and verified the following items as applicable.

Documents Reviewed: Disposal Facility Data for the Hanford IDF PA-RPP-20691, Rev. 0

Analysis Performed By: R. J. Puigh

See Attached FGG Peer Review Checklist for elements checked

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- ______________________________

Checker (printed name, signature, and date): Scott H. Finfrock ______ 4/29/04

Organizational Manager (printed name, signature and date): Raymond J. Puigh ______ 4/29/04

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-20691, Revision 0
Title: Disposal Facility Data For The Hanford Integrated Disposal Facility Performance Assessment
Author: R. J. Puigh
Date: April 29, 2004
Scope of Review: The entire document.

Yes No* NA	
[ ][ ][X] **	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X][ ][ ]	Problem completely defined.
[ ][ ][X]	Accident scenarios developed in a clear and logical manner.
[X][ ][ ]	Necessary assumptions explicitly stated and supported.
[ ][ ][X]	Computer codes and data files documented.
[X][ ][ ]	Data used in calculations explicitly stated in document.
[X][ ][ ]	Data checked for consistency with original source information as applicable.
[ ][ ][X]	Mathematical derivations checked including dimensional consistency of results.
[ ][ ][X]	Models appropriate and used within range of validity, or use outside range of established validity justified.
[X][ ][ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ][ ][X]	Software input correct and consistent with document reviewed.
[ ][ ][X]	Software output consistent with input and with results reported in document reviewed.
[ ][ ][X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ][ ][X]	Safety margins consistent with good engineering practices.
[X][ ][ ]	Conclusions consistent with analytical results and applicable limits.
[X][ ][ ]	Results and conclusions address all points required in the problem statement.
[X][ ][ ]	Format consistent with applicable guides or other standards.
[ ] [X]**	Review calculations, comments, and/or notes are attached.
[X][ ][ ]	Document approved (for example, the reviewer affirms the technical accuracy of the document).

Scott H. Finfrock [signature] — Reviewer (printed name and signature)

7/29/04 — Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated, and attached to this checklist. The material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.